
(12) **UK Patent Application** (19) **GB** (11) **2 016 255** **A**

(21) Application No **7907944**

(22) Date of filing
6 Mar 1979

(23) Claims filed
6 Mar 1979

(30) Priority data

(31) **883880**

(32) **6 Mar 1978**

(33) **United States of America**
(US)

(43) Application published
26 Sep 1979

(51) **INT CL² A23L 1/20**
1/36 //
C07G 7/00

(52) Domestic classification
A2B 1C 1J1 1JY 1L 1S
1X
C3H FX

(56) Documents cited

GB 1516733

GB 1477983

GB 1318833

GB 1318596

GB 1202678

GB 926253

GB 551692

GB 513896

(58) Field of search

A2B

C3H

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(54) **Process for preparing cheese analogs**

(57) Synthetic cheese like products are prepared by the steps of forming an aqueous slurry of full-fat oleaginous seed material at a pH below about 3.5, subjecting the aqueous slurry to shear conditions sufficient to disrupt the natural cellular structure of the seed material, adjusting the pH of the slurry to the seed protein's isoelectric point to precipitate protein, separating the entire insoluble portion from the slurry, homogenizing the insoluble portion, adjusting the pH of the homogenized insoluble portion to about 5.3 to 7.0, and blending sufficient flavouring agents therewith to produce a cheese-like flavour. The seed material may be beans, lentils, peanuts, soybeans, rapeseed, safflower, or sunflower.

Additional fats may be blended with the product. Gums, colourants, casein, albumin, preservatives, salt and starch may also be present.

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SPECIFICATION

Process for preparing cheese analogs

5 BACKGROUND OF THE INVENTION

Dairy-like, in particular cheese-like, analogs from vegetable proteins have been described in U.S. Patents Nos. 4,016,295; 3,891,778; 3,857,977; 3,857,970; 3,809,771; 10 3,743,516; 3,743,514; and 2,479,040. The extraction of protein from oilseed materials has been discussed in Food Technology 18, (1963); N.Y. Agri. Expt. Sta. Form Res. 28, 4 (1962) and disclosed in U.S. Patents 15 Nos. 3,968,097; 2,534,227; 2,534,226 and 2,272,562. The effect of pH on the flavor of plant protein extracts has been disclosed in the J. of Food Science 35, 343 (1970). These references describe various 20 processes and mixtures of vegetable proteins, binders, gums, flavors and colors which have been employed to simulate dairy-like materials. Although the prior art methods result in products having some cheese-like properties, 25 they have generally lacked the desired textural, fatty mouthfeel characteristics of natural cheese. As a result, these products have not been widely accepted by the consumer as true substitutes for natural cheese.

30 SUMMARY OF THE INVENTION

In accordance with the present invention, a process is provided for preparing improved cheese-like analogs having improved textural 35 and mouthfeel characteristics. The process comprises the steps of forming an aqueous slurry of a full-fat oleaginous seed material at a pH below about 3.5, subjecting the aqueous slurry to shear conditions sufficient to disrupt 40 the natural cellular structure of the seed material, adjusting the pH of the slurry to the oleaginous seed protein's isoelectric point to precipitate the protein, separating the entire insoluble portion from the slurry, homogeniz- 45 ing the insoluble portion, adjusting the pH of the homogenized insoluble portion to about pH 5.3 to 7.0, and blending sufficient flavors therewith to produce a cheese-like flavor.

50 DESCRIPTION OF THE INVENTION

The full-fat oleaginous seed materials used in the practice of the present invention include legumes, rapeseed, safflower, sunflower and 55 the like. Legumes such as beans, lentils, peanut, soybeans and the like are preferred. The most preferred leguminous seed is soybean.

An aqueous slurry of the full-fat leaginous seed material is formed having a pH below 60 about 3.5. In this pH range, the protein, carbohydrates, flavors and colors from the oleaginous seed material are soluble. The pH is preferably maintained at a value below about 2.2 to produce a bland flavored pro- 65 duct. Most preferably, the pH is adjusted to a

value between about 1.5 and 2.2. It has been found that a pH much above 3.5 results in the extraction or solubilization of little protein. This acid range is maintained by the addition 70 of any suitable acidic means, such as hydrochloric acid, phosphoric acid, sulfuric acid and the like. Preferably the aqueous slurry contains about 5 to 20 percent oleaginous seed material by weight based upon the total 75 weight of the slurry.

Preferably the aqueous slurry is formed using comminuted, full-fat oleaginous seed material prepared by washing and subdividing the whole full-fat seed material to a fine 80 particle size. Well known means such as grinding, flaking, pulverizing and the like may be employed to comminute the seed material. To avoid the production of off-flavors or odor and to avoid subsequent fat separation, the 85 temperature generated during comminution should be kept below about 28°C.

The aqueous slurry is then subjected to shear conditions for a period of time sufficient to disrupt the cellular structure of the oleage- 90 nous seed material, to reduce the particle size of the oleaginous seed material and to form an uniform, nonparticulate slurry. Suitable means for shearing the slurry include the use of any high speed dispersing, mixing, grind- 95 ing or homogenizing device. Usually 5 to 10 minutes of shearing is sufficient to disrupt the natural cellular structure. Some particularly troublesome slurries may require longer shear- ing times up to about 60 minutes.

100 The pH of the sheared aqueous slurry is then adjusted to the isoelectric pH point of the oleaginous protein to precipitate the protein. The isoelectric point, especially for the legumi- 105 nous seed protein, is between pH 4.4 and 4.8. Suitable basic means, such as sodium hydroxide, potassium hydroxide, trisodium phosphate and the like, may be employed to adjust the pH of the slurry to the desired isoelectric point. The insoluble portion of the 110 slurry contains natural fats, fibers, carbohydrates and the like in addition to precipitated protein. In some instances it is desirable to lower the natural fiber and carbohydrate con- 115 tent of the insoluble portion of the aqueous sheared slurry. This can be accomplished by first clarifying the sheared slurry prior to the isoelectric pH adjustment. Suitable means for clarifying the sheared slurry include centrifugation, filtration, decantation and the like.

120 The resulting insoluble portion of the pH adjusted slurry is then separated from the soluble portion containing soluble carbohy- drates, colors and flavors. Suitable separation means include centrifugation, filtration, decan- 125 tation and the like. It has been found that the texture of the cheese-like end products is influenced by the moisture content of the separated solids. For example, about 45 to 60 percent moisture by weight in the solids re- 130 sults in a product having a hard, dry, sliceable

texture, whereas about 60 to 75 percent moisture by weight in the solids results in product having a semi-soft to soft creamy texture. The moisture content of the insoluble portion can be easily controlled by the removal of moisture by the separation means or by the addition of water thereto.

The separated insoluble portion of the slurry is then homogenized to form a uniform, smooth nonparticulate proteinaceous mixture. Suitable homogenizing means include high speed mixing, grinding, homogenizing device and the like.

The pH of the homogenized slurry is then adjusted to about 5.3 to 7.0. The pH is selected to duplicate the pH of natural cheese in the corresponding cheese-like product to be produced. For example, a cheese-like spread or cream cheese may desirably have a pH of about 5.5 to 6.0 while a semi-soft or hard cheese-like may desirably have a pH of about 5.3 to 6.5. Any suitable basic means as described above may be employed to adjust the pH.

Sufficient flavors may be blended with the homogenized slurry to impart a desired cheese-like flavor. Suitable flavoring means include natural flavors, artificial flavors, reaction products, seasoning and the like which combine to provide a "cheese flavor". The selection of such flavors is well-known to those skilled in the food and flavor art. The amount of flavor added will depend upon the type of flavor and the flavoring means but usually will range between about 0.1 to 30 percent by weight based on the dry weight of the homogenized solids.

The homogenized flavored solids may then be shaped to a desired form. Suitable shaping means include the use of plastic or metal moulds, animal or artificial casings and the like as are well-known for this purpose. To avoid subsequent swelling or foaming, it is desirable to remove air which has been incorporated during processing. Deaeration is simply accomplished by any suitable vacuum means.

In a preferred mode of this process, fat is blended with the homogenized solids to simulate fat-containing natural cheese products, such as cheese spreads, hard cheese and the like. Such fats or oils include saturated or unsaturated fats from animal or plant sources which are either in liquid or solid form at about 20°C. Preferably the fats are the unsaturated types from plant sources. The most preferred fats include soybean oil, corn oil, safflowerseed oil, peanut oil and the like.

About 10 to 30 percent fat by weight based on the dry weight of the homogenized solids is blended with the solids. Preferably about 20 to 25 percent fat by weight based on the dry weight of the solids is blended therewith.

To insure uniform blending of the fats with the homogenized solids, it is preferable to

maintain the temperature during blending at about 60°C.

In order to prepare cheese-like products having semi-soft to hard cheese-like textures, the shaped mixture is heated for a sufficient period of time to set the protein in a stable, firm physical form. The temperature and heating period selected have a direct influence on the firmness and the moisture content (dryness) of the finished product. Preferably the shaped mixture is heated to an internal temperature of about 70°C to 100°C. The use of temperatures from about 82°C to 95°C for about 30 to 60 minutes result in hard textured products. Lower temperatures of from about 70° to 80°C for similar heating periods result in a softer textured product. A suitable temperature and heating period thus can be selected to produce a product having the desired texture and moisture content.

Other ingredients may be added to the homogenized solids to improve the color, meltability, mouthfeel, taste or texture of the cheese-like product. Such ingredients include vegetable gums, artificial and natural colorants, casein, albumin, preservatives, salts, starch and the like which are well-known for these purposes.

The following examples further illustrate the present invention and are not intended to limit the breadth described above.

EXAMPLE 1

This example illustrates the preparation from soybeans of a cheese analog with a hard cheese-like texture.

Whole, full-fat soybeans (22.7 kilograms) were ground in a Fitz mill to pass through a 0.125 inch screen opening and then added to an aqueous mixture at pH 1.7 containing 272.7 kilograms water, 7.2 kilograms phosphoric acid (85%, food grade), 114 grams sodium sulfite and 28 grams of an antifoaming agent (this mixture contains about 7.6 weight percent soybeans based on the total weight of the slurry). After mixing, the pH of the slurry rose to pH 2.2. The aqueous slurry was then passed through an in-line shearing device (Tekmar Dispenser type OR-3-616, Tekmar Co. Cincinnati, Ohio) having three (coarse, medium and fine) grinding heads and into a holding tank. The pH of the sheared slurry was then adjusted to pH 4.6 by the addition of 10 weight percent aqueous sodium hydroxide to precipitate the protein. The insoluble portion containing precipitated protein and other insoluble constituents was then separated from the soluble portion of the slurry by centrifugation. The separated solids contained about 83 weight percent water. The separated solids were then passed through an homogenizer (Manton Gaulin type 15M8TRA) to produce a smooth textured uniform mixture. The pH of the homogenized mixture was adjusted to pH 5.8 by the addition of 10

weight percent sodium hydroxide.

Four hundred grams of the resulting mixture were heated to about 71°C and blended with 95 ml water, 80 grams melted Crisco

- 5 (hydrogenated soybean oil, 75°C), 2.5 grams of hydrated calcium carageenan in 60 ml water and 92 grams of cheese flavors. The mixture was blended for 30 minutes to a uniform smooth consistency. The mixture was
- 10 then deaerated *in vacuo*, moulded and heated in a steam bath for 45 minutes (the internal temperature reached 90°C during the last 10 minutes of heating) to form a stable shaped form. After cooling, the shaped product was
- 15 removed from the mould. The resulting cheese analog had the texture, mouthfeel and flavor of a hard cheese similar to cheddar cheese.

20 EXAMPLE 2

This example illustrates the preparation from peanuts of a cheese analog having a semi-hard cheese-like texture.

- Raw, whole, blanched, full-fat peanuts (500
- 25 grams) were added to 3000 ml of water which had been previously adjusted to pH 1.6 by the addition of 54 ml of phosphoric acid (85%, food grade). This mixture contained about 14.3 weight percent peanuts based on
- 30 the total weight of the slurry. The aqueous mixture was then subjected to shear conditions using a submerged grinder (Tekmar type SD-45) for 10 minutes to comminute the
- 35 peanuts and form a uniform non-particulate slurry. After grinding, the pH of the slurry was 2.1. The pH of the sheared slurry was then adjusted to pH 4.6 by the addition of 10% aqueous sodium hydroxide to precipitate the
- 40 protein and other insoluble constituents. The insoluble portion was filtered from the slurry and collected onto layers of cheese cloth without squeezing. Two hundred ml of water were added to the separated mixture to adjust the
- 45 solids content to about 28 weight percent. The resulting solids were passed through a hand homogenizer to produce a uniform, smooth-textured mixture. The pH of the homogenized mixture was adjusted to pH 5.8 by
- 50 the addition of 10 weight percent aqueous sodium hydroxide. The moist solids were then heated to 50°C and 35 grams of melted Crisco were added with constant stirring. After about 5 minutes, 1.0 gram of hydrated
- 55 calcium carageenan was added and followed by the addition of 30 grams of cheese flavor. After the ingredients were uniformly blended, the mixture was placed in a metal mould and heated in a steam bath for 45
- 60 minutes. The internal temperature of the mixture reached about 90°C during heating. The mixture was cooled and the shaped product removed from the mould. The resulting
- 65 cheese analog had the texture, mouthfeel and flavor of a semi-hard cheese similar to Colby cheese.

EXAMPLE 3

This example illustrates the preparation from soybeans of cheese analogs having textures similar to various types of cheese.

- 70 Whole, full-fat soybeans (22.7 kilograms) were added to an aqueous mixture at about pH 1.65 containing 272.7 kilograms water, 6.36 kg of phosphoric acid (38%, food grade) and 114 grams of sodium sulfite (this mixture
- 75 contains about 7.6 weight percent soybeans based on the total weight of the mixture). The entire mixture was then passed through an inline shearing device (Tekmar Disperser type DR-3-616) to reduce the size of the soybeans
- 80 to a fine particle size. The insoluble portion of the sheared mixture containing insoluble cellular material (fiber, carbohydrates) was separated by centrifugation from the soluble portion containing protein, fats and other soluble
- 85 constituents. The pH of the soluble portion was adjusted to pH 4.6 by the addition of aqueous sodium hydroxide (50%, 757 ml) to precipitate protein and other constituents insoluble at this pH. The precipitated insoluble
- 90 solids were removed from the mixture by centrifugation and washed in the centrifuge with 272.7 kg of water. The separated solids, about 22 kilograms, had a moisture content of about 68 weight percent. The solids were
- 95 analyzed and found to contain the following on a weight percent basis:

Protein	57.8
Fat	34.6
100 Carbohydrates (by difference)	7.6

A. Preparation of a cheese analog similar to cream cheese

- Four hundred grams of the separated solids
- 105 prepared above were vigorously agitated in a laboratory blender to a smooth uniform consistency. The pH of the agitated solids was adjusted to pH 6.0 by the addition of 10 weight percent aqueous sodium hydroxide.
- 110 The mixture was then moulded and refrigerated to serving temperature. The product was creamy, smooth and bland in taste similar in texture to cream cheese.

115 B. Preparation of a cheese analog similar to flavored cream cheese spread

- Four hundred grams of the separated solids prepared above were vigorously agitated in a laboratory blender to a smooth uniform consistency. The pH of the agitated solids was
- 120 adjusted to pH 5.5 using 10 weight percent aqueous sodium hydroxide. Eighty grams of artificial cheese flavors was uniformly blended with the mixture. The product was moulded
- 125 and refrigerated to serving temperature. The cheese analog was creamy smooth with a good cheese flavor similar to flavored cream cheese spreads.

C. Preparation of a cheese analog similar to processed cheese spread

Four hundred grams of the separated solids prepared above were vigorously agitated in a laboratory blender to a smooth uniform consistency. The pH of the agitated solids was adjusted to pH 6.1 by the addition of 20 weight percent aqueous trisodium phosphate. The mixture was heated to about 60°C. Eighty grams of melted Crisco fat and 1 gram of Keltrol F (xanthan gum) were blended with the mixture. Then 80 grams of natural and artificial cheese flavors and about 180 ml of water were blended with the mixture. The mixture was heated to 60°C and mixed for 16 minutes. The product was moulded and refrigerated to serving temperature. The cheese analog had the texture similar to processed cheese spreads.

D. Preparation of a cheese analog similar to commercial soft cheese.

One thousand grams of the separated solids prepared above were vigorously agitated in a laboratory blender to a smooth uniform consistency. The pH of the agitated mixture was adjusted to pH 5.3 by the addition of 20 weight percent trisodium phosphate. To the mixture there was then added 12 grams of sodium chloride and 94.8 grams of artificial and natural cheese flavors. The mixture was blended for about 30 minutes. The product was deaerated *in vacuo*, moulded and heated in a steam bath for 45 minutes. The internal temperature of the analog reached about 90°C during heating. The product was refrigerated to serving temperature. The cheese analog had a medium firm texture which did not cut clean with a knife and was similar to a commercial soft cheese.

CLAIMS

1. A process for preparing cheese-like analogs, which comprises
 - (a) forming an aqueous slurry containing a full-fat oleaginous seed material having a pH below about 3.5;
 - (b) subjecting the aqueous slurry to shear conditions sufficient to disrupt the natural cellular structure and reduce the particle size of the oleaginous seed material;
 - (c) adjusting the pH of the resulting sheared aqueous slurry to the oleaginous seed protein's isoelectric point to precipitate the protein;
 - (d) separating the entire insoluble portion of the slurry from the soluble portion;
 - (e) homogenizing the insoluble portion of the slurry to a uniform nonparticulate consistency;
 - (f) adjusting the pH of the homogenized slurry to about pH 5.3 to 7.0; and
 - (g) blending sufficient flavouring agents with the homogenized slurry to produce a cheese-like flavour.

2. A process according to Claim 1 wherein the aqueous slurry contains 5 to 20 percent oleaginous seed material by weight based upon the total weight of the slurry.

3. A process according to Claim 1 or 2 wherein the oleaginous seed material is leguminous seed.

4. A process according to Claim 3 wherein the leguminous seed is soybean.

5. A process according to any preceding claim, wherein the full-fat oleaginous seed material in the slurry is comminuted.

6. A process according to any preceding claim wherein 0.1 to 30 percent of flavouring agents, by weight based on the dry weight of homogenized solids, are blended with the homogenized solids.

7. A process according to any claim preceding wherein fat is blended with the homogenized slurry.

8. A process according to Claim 7 wherein 10 to 30 percent fat, by weight based on the dry weight of homogenized solids, is blended with the homogenized slurry.

9. A process according to claim 7 or 8 wherein the fat-containing blend is heated to about 60°C.

10. A process according to any preceding claim further comprising shaping the homogenized flavoured solids to a desired form.

11. A process according to Claim 10 wherein the shaped solids are heated to set the protein in a stable physical form.

12. A process according to Claim 10, wherein fat is blended with the homogenized slurry, the fat-containing blend is heated to about 60°C and the shaped solids are heated to an internal temperature of about 70°C to 100°C.

13. A process according to Claim 12 wherein the shaped solids are heated to an internal temperature of about 70°C to 80°C for a sufficient period of time to form a semi-soft cheese-like analog.

14. A process according to Claim 12 wherein the shaped solids are heated to an internal temperature of about 82° to 95°C for a sufficient period of time to form a hard cheese-like analog.

15. A process according to any preceding claim, wherein the sheared aqueous slurry is clarified before its pH is adjusted to the isoelectric point of the protein.

16. A process according to Claim 1, substantially as described in Example 1, 2, 3A, 3B, 3C, or 3D.

17. A synthetic cheese-like foodstuff produced by a process claimed in any preceding claim.

18. A cream cheese analog produced by a process claimed in Claim 1.

19. A cheese spread analog produced by a process claimed in Claim 9.

20. A semi-soft cheese analog produced by a process claimed in Claim 13.

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21. A hard cheese analog produced by a process claimed in Claim 14.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd.—1979.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.